Image $f(i,j)$ ⟶ Image $F(u,v)$

DCT (Discrete Cosine Transform)

→ Decorrelation of input signal in a data-independent manner.

$$F(u,v) = \frac{2C(u)C(v)}{\sqrt{MN}} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} \cos\frac{(2i+1)u\pi}{2M} \cos\frac{(2j+1)v\pi}{2N} f(i,j)$$

17/3/22

JPEG Compression pipeline

Step 1: YCrCb format conversion [YUV]

Step 2: To 4:2:0 subsampling.

Step 3: To 8×8 grid size

Step 4: Each 8×8 block undergoes a DCT (Discrete Cosine Transform) Transformation

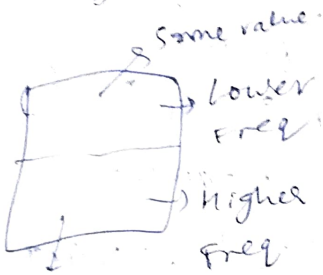
Step 5: Quantization

Using $F_Q(u,v) = \left[\frac{F(u,v)}{Q(u,v)}\right]$

$Q(u,v)$ from quantization table

Lower freq → Quantization is low

Higher freq → Q — is high



Step 6 : Quantized Co-effecients FQ(u,v) are then encoded into an intermediatary pattern.

Step 7 : DCT blocks.

Step 8 : Intermediary representation are then entropy coded using codes supplied by JPEG organization.

19/9/22

Mid prep :

Step 1 : In DCT block, first component is DC component remaining all are AC comp

29/3/22 DC co-effecients - Diff pulse code modul (D

AC co-effec — Scanned in Zig-Zag order

→ We use PPCM so that avg no of bits required to encoded is less.

→ Resulting sequence is entropy coded as many 0's are present.

Intermediatory rep:

DC co-effecient repr

Symbol-1 (SIZE)

Symbol-2 (AMPLITUDE)

AC coeff repr

Symbol-1 (RUNLENGTH, SIZE)

Symbol-2 (AMPLITUDE)

the no. of zeroes that preceeds the no.

→ Negative no's are represented as compliment

→ When all zeroes are present, we can write [End of Block] → EOB

Step 8 :-

Symbol 1 → Huffman encoding

Symbol 2 → variable length encoding

→ Runlength & Size are only 4-bits each → only 15 zeros preced

→ If there is more than 15 zeroes, then special extension code (15,0) is used for symbol 1

→ If Size is 1, Amplitude → -1, 1

2, Amplitude → -3, -2, 2, 3

-1023 -512, 512, 1023

Intermediatry Symbol	Binary repr[symbol-1]	Binary zip [Symbol-2]

→ Blocky artifacts occur due to quantization at high bit rates [more compression ratio]

2 bits per pixel — Good

0.5 — Bad

0.15 — very Bad

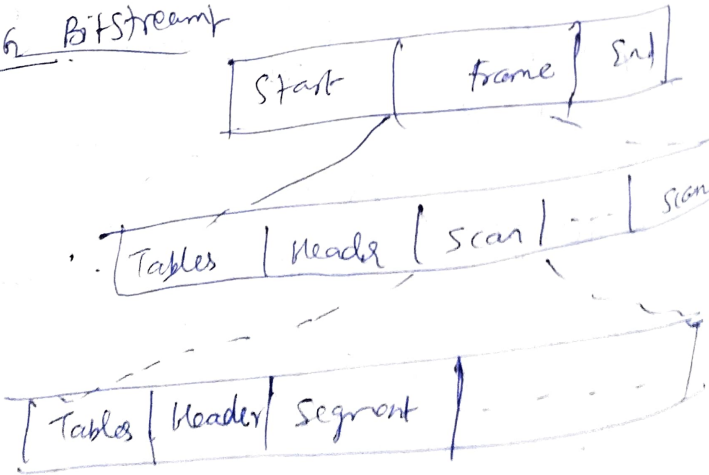
29/3/22

Drawbacks

→ Game, some animation, video. Consider Multimedia

↳ Project ideas

JPEG Bitstream



Low bit-rate compression

Lossy & lossless compression

Random access of the bit stream

Single compression architecture

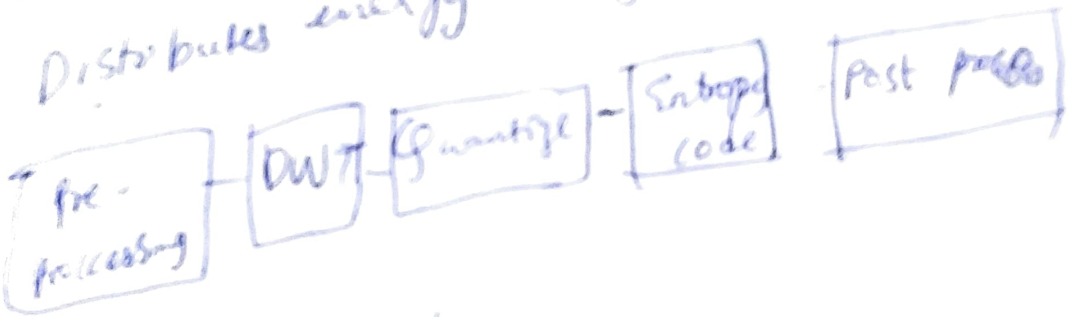
Transmission in noisy environment is difficult

Primary blocks of JPEG

JPEG 2000

→ Makes use of DWT (Discrete wavelet Transform) to compress images

→ Distributes energy among freq coefficients



Pre-processing step :

Tiling :

Partitioning into rectangular blocks (non overlapping)

YCrCb conversion process :

Level Offsetting process -

Shifting the DC levels - Subtracting a constant from each pixel value

1) Discrete Wavelet Transform

→ Represent a signal with good resolution in both time & frequency by using wavelets

→ High & low freq pixels of image are independently processed

→ Image is filtered along x-dimension

→ Rate at which pixel values are changed — Frequency

(↑ High Rate) → High Freq

→ Image will have less high freq images

→ Filter columns

↓ down sample rows by 2

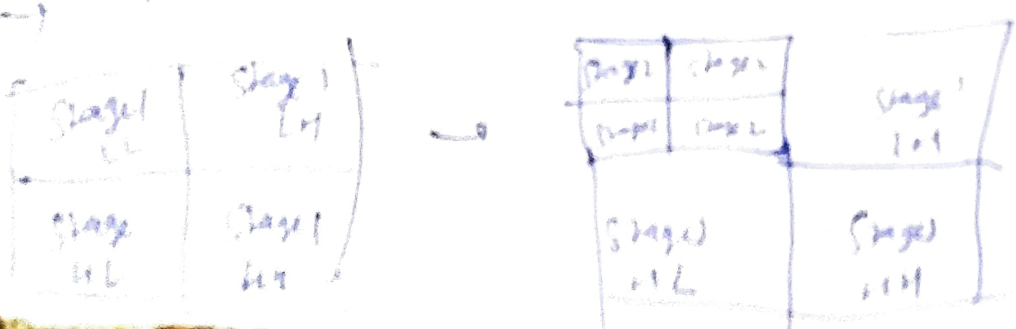
LL	LH
HL	HH

filter signal rows → down sample columns by 2

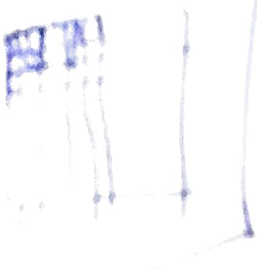
2 stage

→ JPEG 2000 supports from 0 to 32 stages

→



31 | 2 | 22



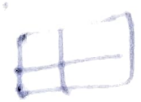
3) Quantization :

- After quantization, coefficients are quantized using scalar quantization.

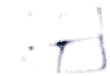
- Quantization reduces coefficients in precision

4) Encoding :

- Block-based encoding scheme known as Embedded Block coding with optimized Truncations (EBCOT).

Precinct :  four code blocks

- Each sub-band is divided into rectangular blocks called precincts.

Code blocks :  → Packet into three or

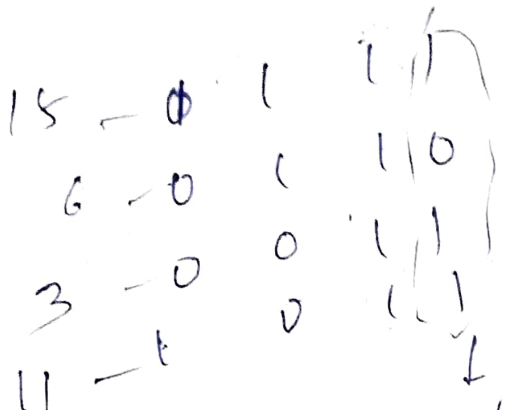
- Tiling rectangles

- Spatially consistent rectangles comprise a packet

- Each code block is encoded independently to the entropy encoder.

Entropy coding + Bit-planes +

→ Co-effecients of code block are seperated into bit-planes



Bit-plane → Context-based Arithmetic coding → Compressed bit Stream

Coding passes → Bit-plane context (represent)

3- Coding passes + [Arithmetic coding]

1) Significance propogation pass +
   - coffecients that are significant already coded

2) Magnitude refinement pass + (current bits of significant co-effecients are encoded)

3) Clean-up pass +

14/22

Arithmetic coding :- Based on probabilities we approximate, the given string, then the last probability value is converted to binary value.

→ Once, the non-zero bit is encoded, the co-efficient becomes significant

→ Once significant, all subsequent bits are refered to as refinement bits

→ Most info is present in low freq sub-band

3 coding passes :-

(1) → Significane propog pass :-

Insignificant bits that have high probab of becoming significant are considered & encoded.

→ Neighbours decide probability of significance.

(2) Magnitude refinement pass :-

Significant co-effecients are refined by their bit representation.

(5) Clean-up pass :-

→ Remaining co-efficients of bitplane are encoded as they have low prob of becoming significant.

=

MQ coder :-

Based on probability, probability changes with incoming bits
Encoded in binary.

— context-based
— Adaptive
— Binary arithmetic coding

→ Context-based adaptive binary arithm coding (MQ coder)

→ JPEG2000 uses an efficient method for encoding uses MQ coder exploiting redundancy in bit-planes

→ Out of 8 neighbours; $2^8 = 256$ different possibilities, only 9 possibilities (context) are taken.

→ Sign encoding :- Only horizontal & vertical neighbours

Special mode (run mode) :

} vertically vertically 4 samples have insignificant neighbours.

→ Each codeblock is independently coded, MQ-coder individual to each codeblock with diff probab

Each codeblock will generate single arithmetic code.

→ 256x256 image
128x128 — level 1 decomposition
64x64 — level 2 decompo

→ Arithmetic coding of bitplane data is referred to as tier-1 (T1) coding.

→ In Tier-2 coding, compressed data into blocks units as packets & layers.

5/4/22

JPEG 2000 Vs JPEG :

→ JPEG 2000 - Have control on resolution (high)

JPEG → Doesn't have control.

→ Region of Interest Encoding

→ Working with compressed images

→ High compression (low bitrates) with better quality

→ Error resilience (especially at robustness: to bit errors when communicating or storage devices are unreliable)

→ support for tiling.

→ JPEG only upto 64k x 64k

→ JPEG 2000 more than 64k.

Video compression :

→ Time ordered sequence of frames, i.e. images

→ Images are having highly redundant data i.e., adjacent pixels are highly correlated

→ Exploit Spatial & Spectral redundancy

M. JPEG :-

→ JPEG compression for each image in frame [Total video].

1

7/4/22

→ Encode the frame difference.

Macro Block :- Compression method works on a block of 16×16 pixels called macro blocks.

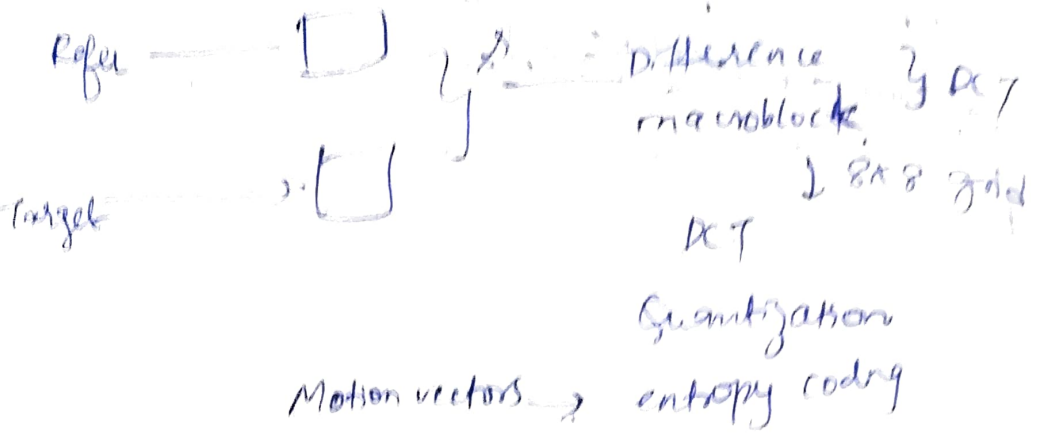
- I (Intra) frame
  → Independent frames
- P (Predictive) or Inter frame
  → Not independent.

Reference frame
Final

Target Frame
Initial

→ Direction of motion vector

P frame :-



→ MPEG-1 Evolution :-

→ MPEG-1 supports only non-interlaced video.
- 4:2:0 chroma subsampling

→ Introduces a new (B-frame)
(Bi-directional predictive coded).

→ Prediction is from previous frame, Forward prediction
" next frame, Backward prediction

→ Reduces frame difference, to achieve higher compression

→ The display order contains I, B, P frames.

Display order - I B B P B B P B B I

Encoding order - I P B B P B B I B B

B → I, P } dependent
P → I, P }
I → Independent

Questions in endsem

B frames need to be buffered causing delay

MPEG

M - Interval between P & preceding I & P frame.

N - Interval between I-frames

(CD's)

Issues :

→ Buffering issue

→ Stores & plays video at low-bit rates (1.5 MBPS)

MPEG-2 :

→ Adopted in DVD's

→ Higher bit rates (4MBPS)

→ MPEG-2 also uses I, P, B frames but with half pixel approximation (½)

→ Interlaced video also only

→ Support for variety of packet formats with error-correction capability:

→ Scalable encoding:

→ Input layer is broken into 2 layers, low freq & high freq layer. Both layers are coded independently, then multiplexed into bit stream.

MPEG-7 (later)

7/4/22

MPEG-4:

→ Version 10 of visual part is known as MPEG-4 AVC (Advanced Visual encoding)

→ Supports many bandwidth ranges.

→ Supports both progressive & interlaced video encoding.

→ Standard is object based encoding

→ 25% better than MPEG-2

→ Temporal scalability

4th Unit.

Done

Multimedia communication (cy

Unit 5 | Networking

- Physical - cables (ethernet)
- Data link - (MAC, LLC ethernet
- network - IP
- transport - TCP UDP
- session - DNS
- presentation - IP, Multicast, IMG
- application - FTP, HTTP, Telnet, SMTP, ARP DNS, DHCP, FTP

OSI - 7 layers

TCP/IP - 4 layers. Application, Transport
app presn session

→ Volume cy continuous nature of multimedia data.

→ Real time cy Interactiveness of multimedia data

→ Rate fluctuations

9/4/22 AR Applica

Manufacturing
Automated
Support
Maintenance
Customer Experience
Entertainment

Static
Dynamic

12/4/22

- SIP (Session Initiation Protocol)
  - → Application-layer protocol
  - → Voice over IP
  - → Proxy, Redirect, Location → Servers
- SDP (Session Description Protocol)
  - Internet Telephony
  - → Provides great flexibility
  - → Uses packet switching
  - → Various degrees of QoS is achieved

→ Network protocol structure for internet telephony.

→ Multimedia conferencing

Types :- 1) Point-to-point conferencing (2 people)
2) Multi-point video conferencing (2 or more)

→ VoIP makes video conferencing possible
→ VoIP relies on special algorithms called codecs (coder-decoder).
- Data compression (coding)
- Data transfer & decompression (decoding)

Features of video conferencing :-
- Screen sharing
- Chat Box
→ File sharing
→ Video call recording
→ Noise cancellation

Video on Demand (VOD) :-
→ Allows users to access videos without a traditional video.

Advantages :- → watch at any time.
→ control what they watch
→ Use media controls.